FIG.1

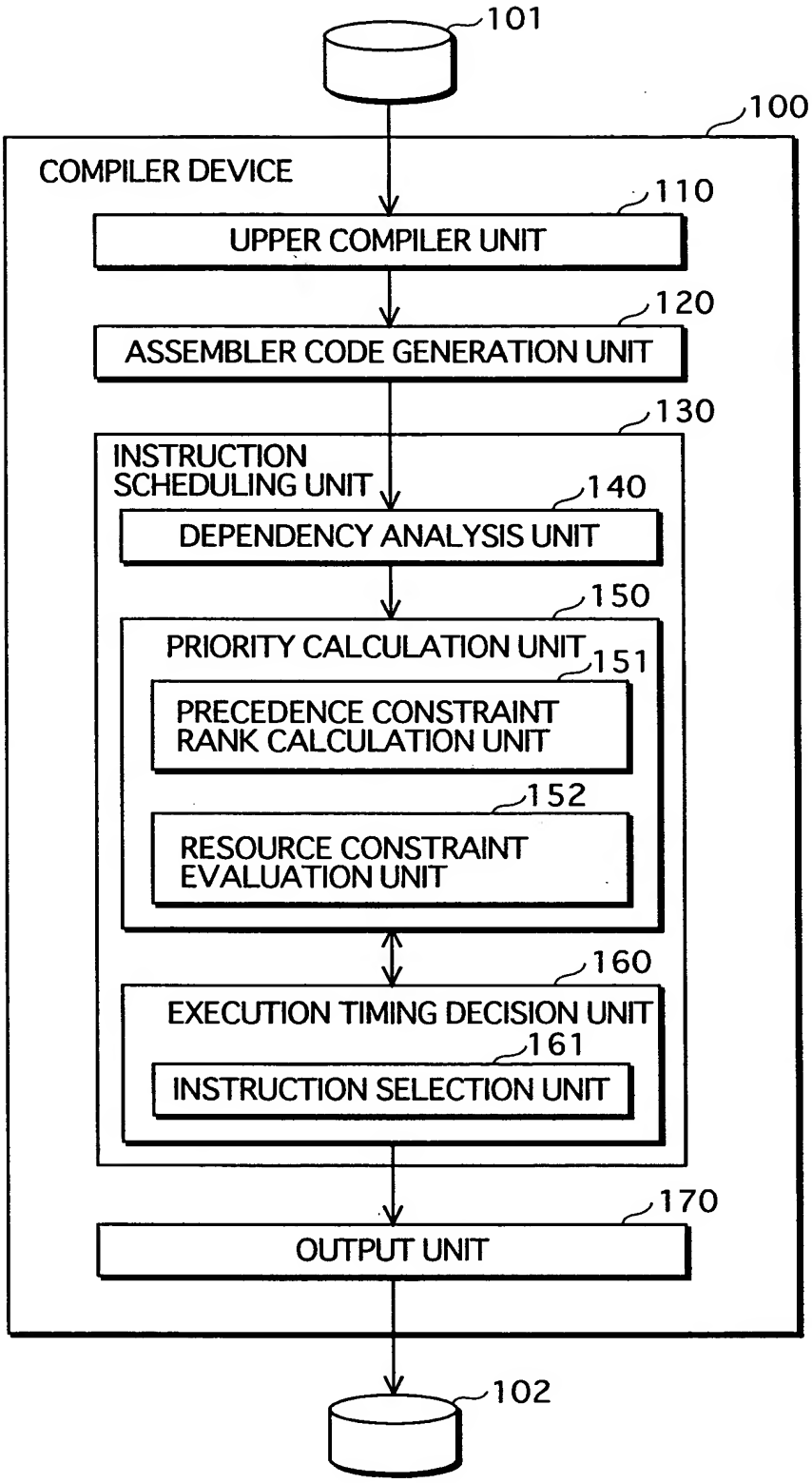
101
100
COMPILER DEVICE
110
UPPER COMPILER UNIT
120
ASSEMBLER CODE GENERATION UNIT
130
INSTRUCTION SCHEDULING UNIT
140
DEPENDENCY ANALYSIS UNIT
150
PRIORITY CALCULATION UNIT
151
PRECEDENCE CONSTRAINT RANK CALCULATION UNIT
152
RESOURCE CONSTRAINT EVALUATION UNIT
160
EXECUTION TIMING DECISION UNIT
161
INSTRUCTION SELECTION UNIT
170
OUTPUT UNIT
102

FIG.2

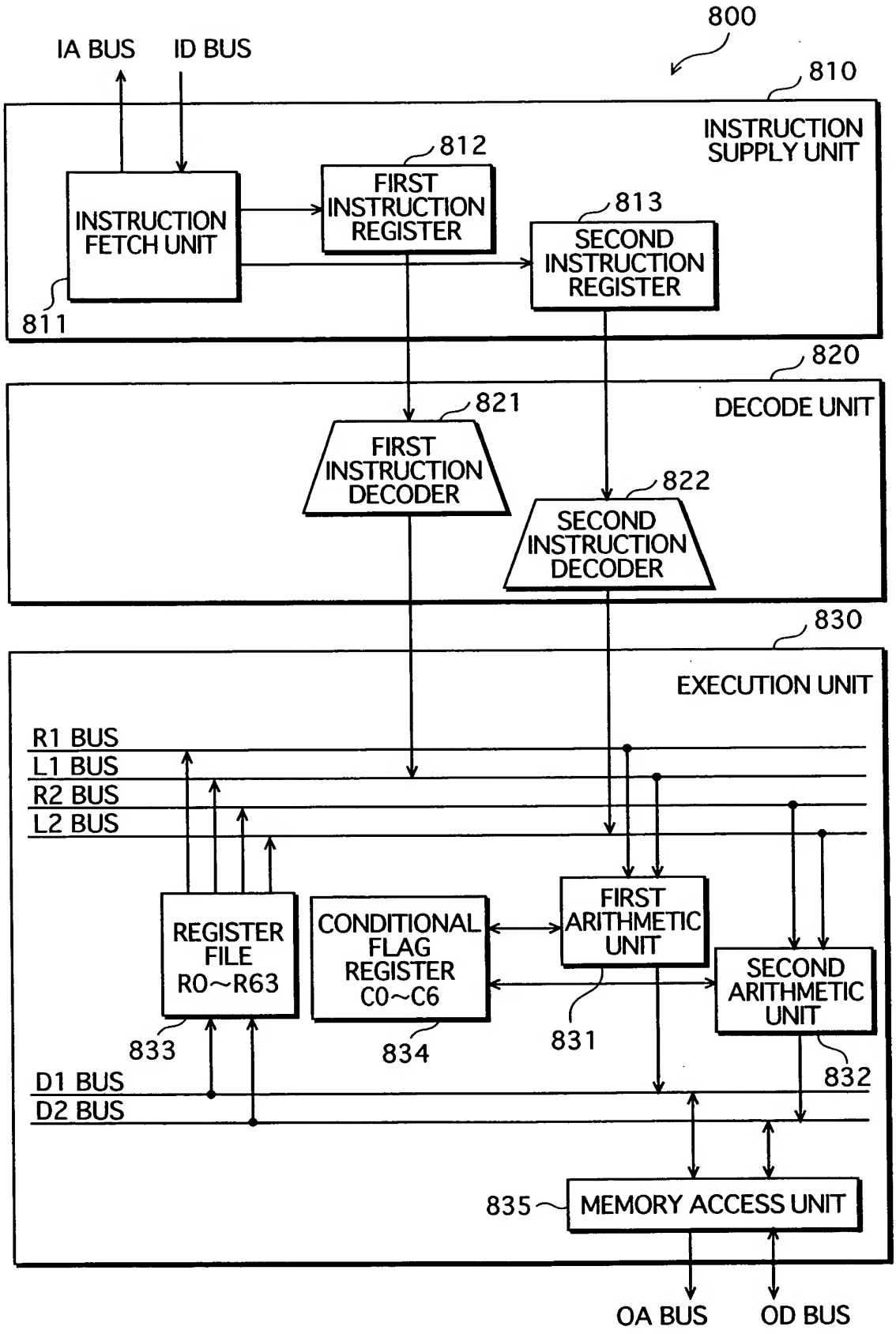
800
IA BUS
ID BUS
810
INSTRUCTION SUPPLY UNIT
812
FIRST INSTRUCTION REGISTER
813
SECOND INSTRUCTION REGISTER
INSTRUCTION FETCH UNIT
811
820
DECODE UNIT
821
FIRST INSTRUCTION DECODER
822
SECOND INSTRUCTION DECODER
830
EXECUTION UNIT
R1 BUS
L1 BUS
R2 BUS
L2 BUS
REGISTER FILE R0~R63
CONDITIONAL FLAG REGISTER C0~C6
FIRST ARITHMETIC UNIT
SECOND ARITHMETIC UNIT
833
834
831
832
D1 BUS
D2 BUS
835
MEMORY ACCESS UNIT
OA BUS
OD BUS

FIG.3

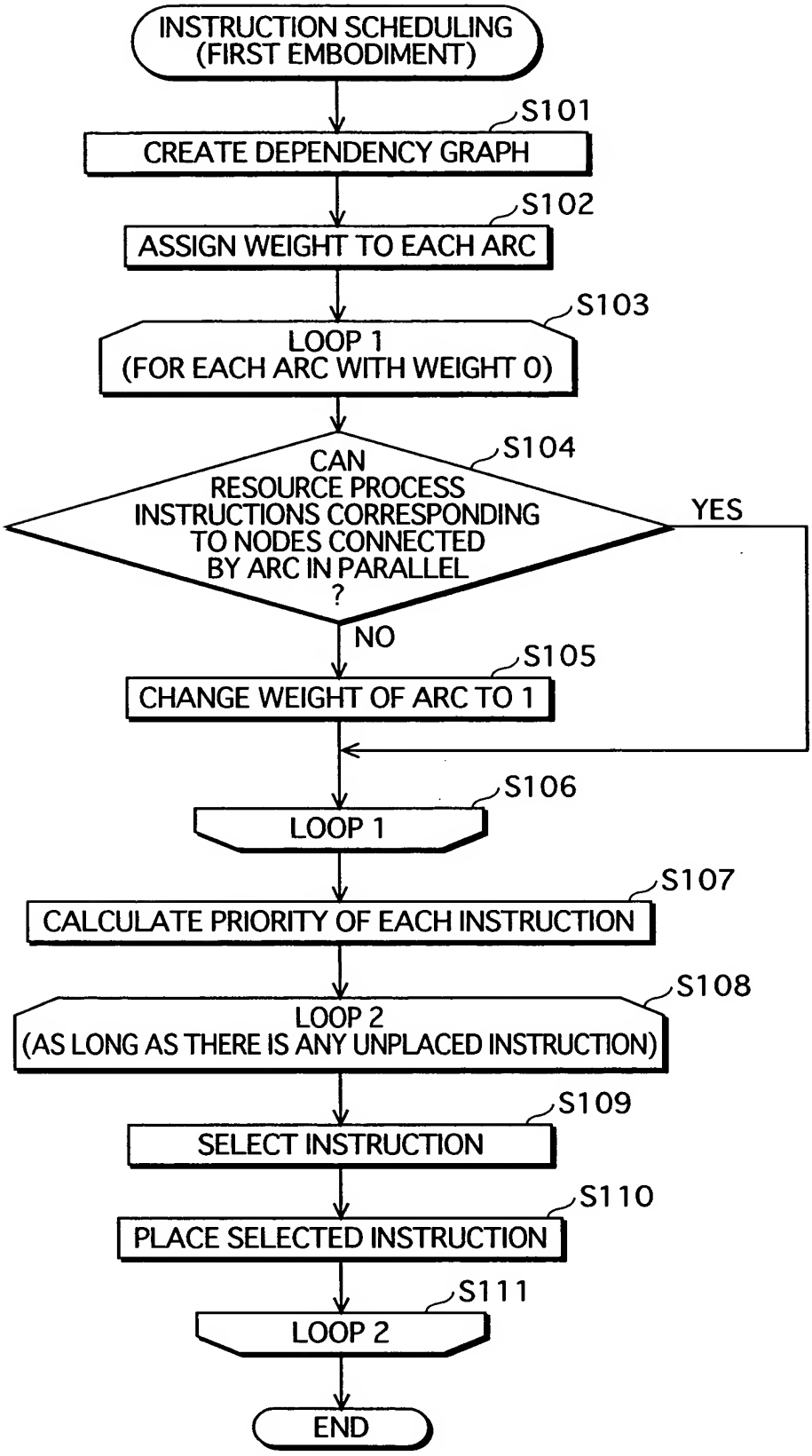
INSTRUCTION SCHEDULING (FIRST EMBODIMENT)
S101
CREATE DEPENDENCY GRAPH
S102
ASSIGN WEIGHT TO EACH ARC
S103
LOOP 1 (FOR EACH ARC WITH WEIGHT 0)
S104
CAN RESOURCE PROCESS INSTRUCTIONS CORRESPONDING TO NODES CONNECTED BY ARC IN PARALLEL ?
YES
NO
S105
CHANGE WEIGHT OF ARC TO 1
S106
LOOP 1
S107
CALCULATE PRIORITY OF EACH INSTRUCTION
S108
LOOP 2 (AS LONG AS THERE IS ANY UNPLACED INSTRUCTION)
S109
SELECT INSTRUCTION
S110
PLACE SELECTED INSTRUCTION
S111
LOOP 2
END

FIG.4

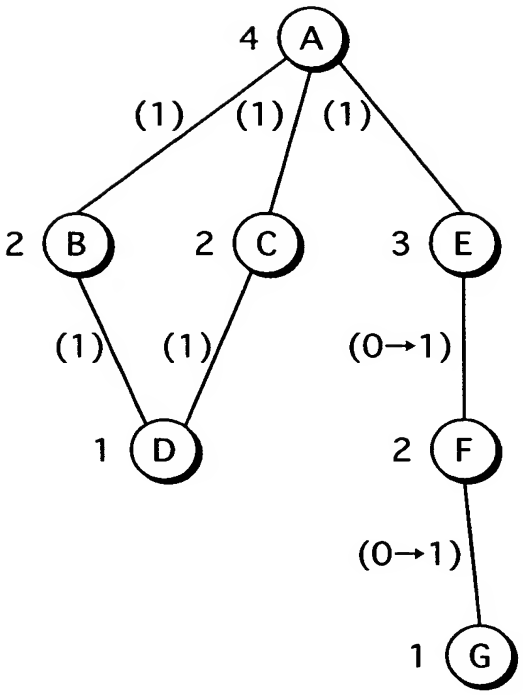

FIG.5

201 CLOCK CYCLE	202 INSTRUCTION 1	203 INSTRUCTION 2
1	ld r0, (r10) · · · Ⓐ (FIRST DECISION)	—
2	st (r11), r0 · · · Ⓔ (SECOND DECISION)	add r3, r0, r1 · · · Ⓑ (THIRD DECISION)
3	add r4, r0, r2 · · · Ⓒ (FOURTH DECISION)	ld r0, (r12) · · · Ⓕ (FIFTH DECISION)
4	or r5, r4, r3 · · · Ⓓ (SIXTH DECISION)	ld r0, (r13) · · · Ⓖ (SEVENTH DECISION)

FIG.6

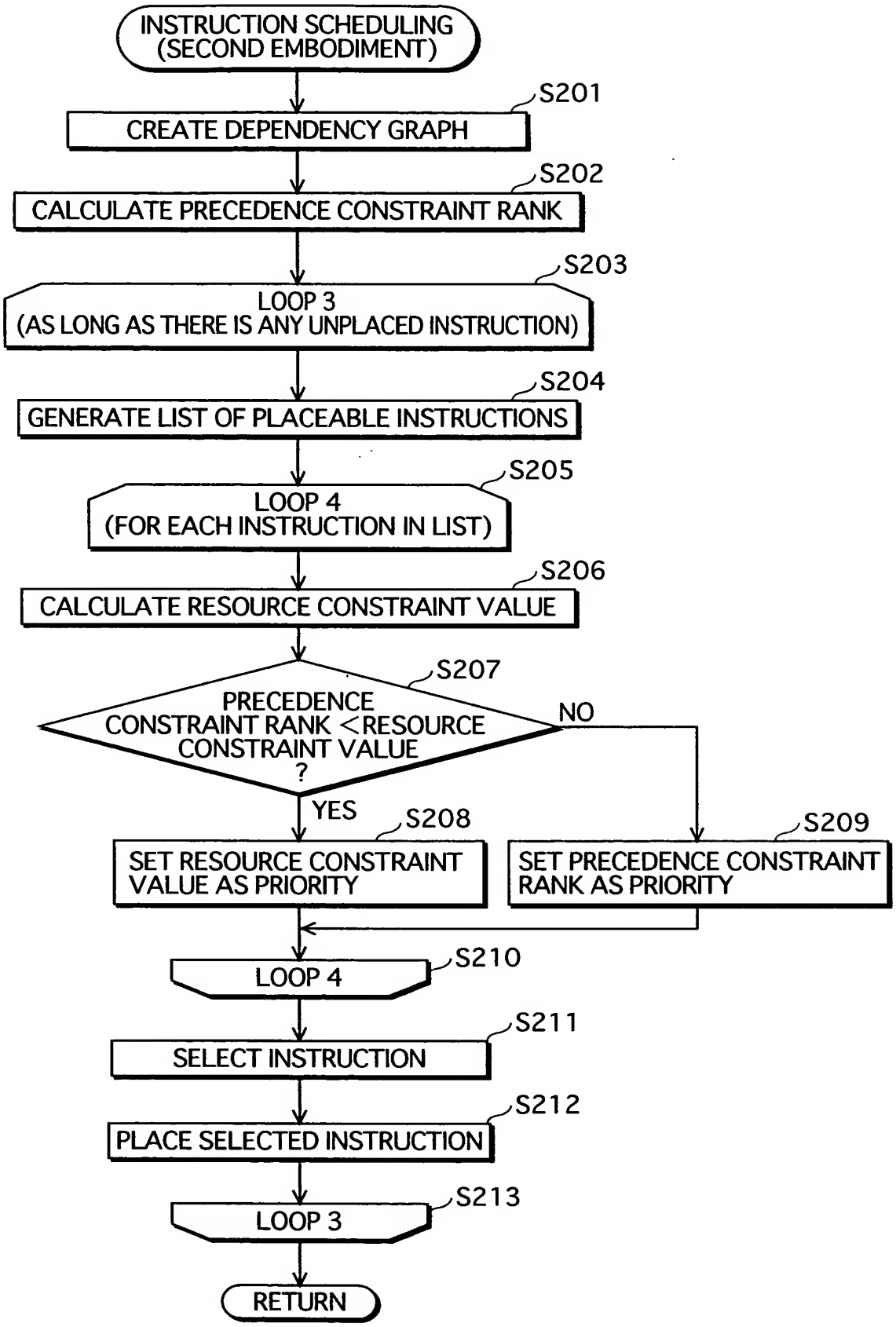
INSTRUCTION SCHEDULING (SECOND EMBODIMENT)
S201
CREATE DEPENDENCY GRAPH
S202
CALCULATE PRECEDENCE CONSTRAINT RANK
S203
LOOP 3 (AS LONG AS THERE IS ANY UNPLACED INSTRUCTION)
S204
GENERATE LIST OF PLACEABLE INSTRUCTIONS
S205
LOOP 4 (FOR EACH INSTRUCTION IN LIST)
S206
CALCULATE RESOURCE CONSTRAINT VALUE
S207
PRECEDENCE CONSTRAINT RANK <RESOURCE CONSTRAINT VALUE ?
NO
YES
S208
SET RESOURCE CONSTRAINT VALUE AS PRIORITY
S209
SET PRECEDENCE CONSTRAINT RANK AS PRIORITY
S210
LOOP 4
S211
SELECT INSTRUCTION
S212
PLACE SELECTED INSTRUCTION
S213
LOOP 3
RETURN

FIG.7

301 INSTRUCTION	302 RESOURCE	303 PRECEDENCE CONSTRAINT RANK	310 FIRST DECISION			320 SECOND DECISION			330 THIRD DECISION			340 FOURTH DECISION		
			PLACEMENT STATE	RESOURCE CONSTRAINT VALUE	PRIORITY	PLACEMENT STATE	RESOURCE CONSTRAINT VALUE	PRIORITY	PLACEMENT STATE	RESOURCE CONSTRAINT VALUE	PRIORITY	PLACEMENT STATE	RESOURCE CONSTRAINT VALUE	PRIORITY
A	M	3	PLACEABLE	4	4	1	–	–	1	–	–	1	–	–
B	A	2	UNPLACED	–	–	PLACEABLE	1.5	2	PLACEABLE	1.5	2	2	–	–
C	A	2	UNPLACED	–	–	PLACEABLE	1.5	2	PLACEABLE	1.5	2	PLACEABLE	1	2
D	A	1	UNPLACED	–	–	UNPLACED	–	–	UNPLACED	–	–	UNPLACED	–	–
E	M	1	UNPLACED	–	–	PLACEABLE	3	3	2	–	–	2	–	–
F	M	1	UNPLACED	–	–	UNPLACED	–	–	PLACEABLE	2	2	PLACEABLE	2	2
G	M	1	UNPLACED	–	–	UNPLACED	–	–	UNPLACED	–	–	UNPLACED	–	–

FIG.8

301 INSTRUCTION	302 RESOURCE	PRECEDENCE CONSTRAINT RANK	303 FIFTH DECISION			350 SIXTH DECISION			360 SEVENTH DECISION			370 380 PLACEMENT RESULT
			PLACEMENT STATE	RESOURCE CONSTRAINT VALUE	PRIORITY	PLACEMENT STATE	RESOURCE CONSTRAINT VALUE	PRIORITY	PLACEMENT STATE	RESOURCE CONSTRAINT VALUE	PRIORITY	
A	M	3	1	–	–	1	–	–	1	–	–	1
B	A	2	2	–	–	2	–	–	2	–	–	2
C	A	2	3	–	–	3	–	–	3	–	–	3
D	A	1	PLACEABLE	0.5	1	PLACEABLE	0.5	1	4	–	–	4
E	M	1	2	–	–	2	–	–	2	–	–	2
F	M	1	PLACEABLE	2	2	3	–	–	3	–	–	3
G	M	1	UNPLACED	–	–	PLACEABLE	1	1	PLACEABLE	1	1	4

FIG.9

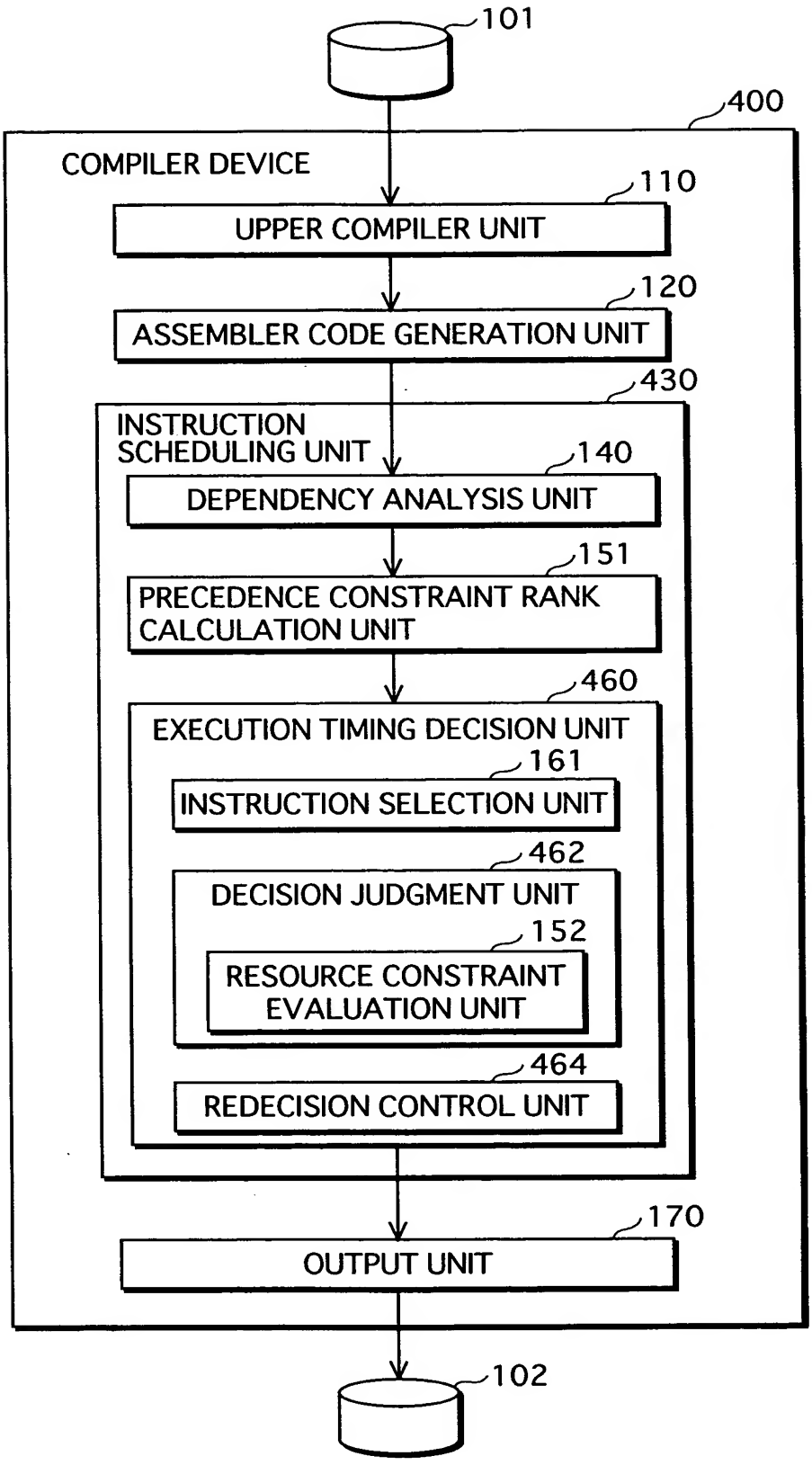
101
400
COMPILER DEVICE
110
UPPER COMPILER UNIT
120
ASSEMBLER CODE GENERATION UNIT
430
INSTRUCTION SCHEDULING UNIT
140
DEPENDENCY ANALYSIS UNIT
151
PRECEDENCE CONSTRAINT RANK CALCULATION UNIT
460
EXECUTION TIMING DECISION UNIT
161
INSTRUCTION SELECTION UNIT
462
DECISION JUDGMENT UNIT
152
RESOURCE CONSTRAINT EVALUATION UNIT
464
REDECISION CONTROL UNIT
170
OUTPUT UNIT
102

FIG.10

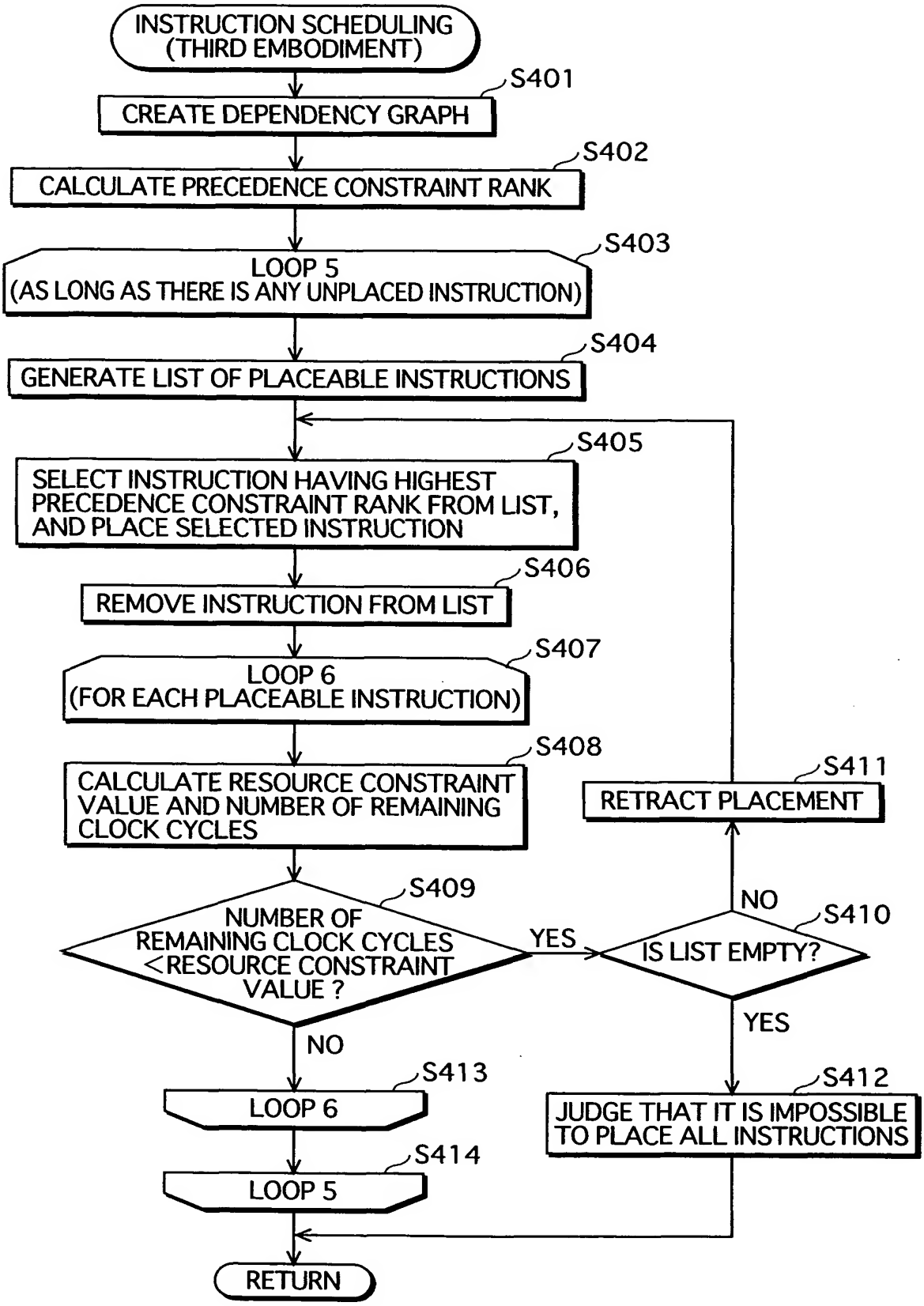
INSTRUCTION SCHEDULING (THIRD EMBODIMENT)
S401
CREATE DEPENDENCY GRAPH
S402
CALCULATE PRECEDENCE CONSTRAINT RANK
S403
LOOP 5 (AS LONG AS THERE IS ANY UNPLACED INSTRUCTION)
S404
GENERATE LIST OF PLACEABLE INSTRUCTIONS
S405
SELECT INSTRUCTION HAVING HIGHEST PRECEDENCE CONSTRAINT RANK FROM LIST, AND PLACE SELECTED INSTRUCTION
S406
REMOVE INSTRUCTION FROM LIST
S407
LOOP 6 (FOR EACH PLACEABLE INSTRUCTION)
S408
CALCULATE RESOURCE CONSTRAINT VALUE AND NUMBER OF REMAINING CLOCK CYCLES
S409
NUMBER OF REMAINING CLOCK CYCLES <RESOURCE CONSTRAINT VALUE ?
YES
NO
S410
IS LIST EMPTY?
NO
YES
S411
RETRACT PLACEMENT
S412
JUDGE THAT IT IS IMPOSSIBLE TO PLACE ALL INSTRUCTIONS
S413
LOOP 6
S414
LOOP 5
RETURN

FIG.11

501 INSTRUCTION	502 RESOURCE	503 PRECEDENCE CONSTRAINT RANK	510 FIRST DECISION			520 SECOND DECISION			530 THIRD DECISION			540 THIRD DECISION (REDECISION)		
			PLACEMENT STATE	NUMBER OF REMAINING CYCLES	RESOURCE CONSTRAINT VALUE	PLACEMENT STATE	NUMBER OF REMAINING CYCLES	RESOURCE CONSTRAINT VALUE	PLACEMENT STATE	NUMBER OF REMAINING CYCLES	RESOURCE CONSTRAINT VALUE	PLACEMENT STATE	NUMBER OF REMAINING CYCLES	RESOURCE CONSTRAINT VALUE
A	M	3	PLACEABLE (1)	–	–	1	–	–	1	–	–	1	–	–
B	A	2	UNPLACED	3	1.5	PLACEABLE (2)	–	–	2	–	–	2	–	–
C	A	2	UNPLACED	3	1.5	PLACEABLE	3	1	PLACEABLE (2)	–	–	PLACEMENT RETRACTED	2	1
D	A	1	UNPLACED	–	–	UNPLACED	–	–	UNPLACED	2	0.5	UNPLACED	–	–
E	M	1	UNPLACED	3	3	PLACEABLE	3	3	PLACEABLE	2	3	PLACEABLE (2)	–	–
F	M	1	UNPLACED	–	–	UNPLACED	–	–	UNPLACED	–	–	UNPLACED	2	2
G	M	1	UNPLACED	–	–	UNPLACED	–	–	UNPLACED	–	–	UNPLACED	–	–

FIG.12

501 INSTRUCTION	502 RESOURCE	503 PRECEDENCE CONSTRAINT RANK	550 FOURTH DECISION			560 FIFTH DECISION			570 SIXTH DECISION			580 SEVENTH DECISION			590 PLACEMENT RESULT
			PLACEMENT STATE	NUMBER OF REMAINING CYCLES	RESOURCE CONSTRAINT VALUE	PLACEMENT STATE	NUMBER OF REMAINING CYCLES	RESOURCE CONSTRAINT VALUE	PLACEMENT STATE	NUMBER OF REMAINING CYCLES	RESOURCE CONSTRAINT VALUE	PLACEMENT STATE	NUMBER OF REMAINING CYCLES	RESOURCE CONSTRAINT VALUE	
A	M	3	1	–	–	1	–	–	1	–	–	1	–	–	1
B	A	2	2	–	–	2	–	–	2	–	–	2	–	–	2
C	A	2	PLACEABLE (3)	–	–	3	–	–	3	–	–	3	–	–	3
D	A	1	UNPLACED	1	0.5	PLACEABLE (4)	–	–	4	–	–	4	–	–	4
E	M	1	2	–	–	2	–	–	2	–	–	2	–	–	2
F	M	1	PLACEABLE	2	2	PLACEABLE	2	2	PLACEABLE (3)	–	–	3	–	–	3
G	M	1	UNPLACED	–	–	UNPLACED	–	–	UNPLACED	1	1	PLACEABLE (4)	–	–	4

FIG.13

601 CLOCK CYCLE	602 INSTRUCTION 1	603 INSTRUCTION 2
1	ld r0, (r10) · · · Ⓐ (FIRST DECISION)	—
2	add r3, r0, r1 · · · Ⓑ (SECOND DECISION)	st (r11), r0 · · · Ⓔ (THIRD DECISION)
3	add r4, r0, r2 · · · Ⓒ (FOURTH DECISION)	ld r0, (r12) · · · Ⓕ (SIXTH DECISION)
4	or r5, r4, r3 · · · Ⓓ (FIFTH DECISION)	ld r0, (r13) · · · Ⓖ (SEVENTH DECISION)

FIG.14

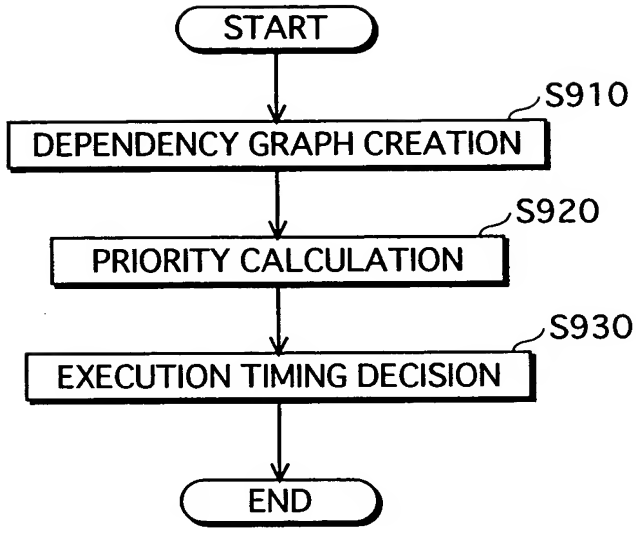
START
S910
DEPENDENCY GRAPH CREATION
S920
PRIORITY CALCULATION
S930
EXECUTION TIMING DECISION
END

FIG.15

```
ld      r0, (r10)      ・・・ Ⓐ
add     r3, r0, r1     ・・・ Ⓑ
add     r4, r0, r2     ・・・ Ⓒ
or      r5, r4, r3     ・・・ Ⓓ
st      (r11), r0      ・・・ Ⓔ
ld      r0, (r12)      ・・・ Ⓕ
ld      r0, (r13)      ・・・ Ⓖ
```

FIG.16

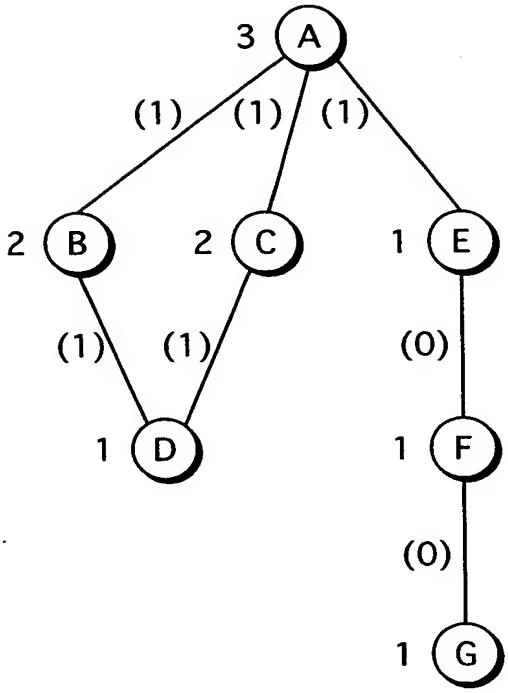

FIG.17

901 CLOCK CYCLE	902 INSTRUCTION 1	903 INSTRUCTION 2
1	ld r0, (r10) ・・・Ⓐ (FIRST DECISION)	—
2	add r3, r0, r1 ・・・Ⓑ (SECOND DECISION)	add r4, r0 r2 ・・・ Ⓒ (THIRD DECISION)
3	or r5, r4, r3 ・・・Ⓓ (FOURTH DECISION)	st (r11), r0 ・・・Ⓔ (FIFTH DECISION)
4	ld r0, (r12) ・・・Ⓕ (SIXTH DECISION)	—
5	ld r0, (r13) ・・・Ⓖ (SEVENTH DECISION)	—